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**ENVIRONMENTAL RESEARCH AND ITS IMPLICATIONS  
TO THE LONG-RANGE POWER POSITION  
(Unedited Draft)**

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ENVIRONMENTAL RESEARCH AND ITS IMPLICATIONS  
TO THE LONG-RANGE POWER POSITION

Introduction

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The rapid rise of Soviet industrialization and the associated development of its nuclear military power has aroused many queries on the origins and dynamics of such an accomplishment and its prospective bearing on the future of the power struggle.

The thesis of this paper is very simple. The basis of Soviet power, including its rapid rise from early post-feudalism to a major industrial nation in less than 50 years was due to an early foundation of all Soviet development upon the concepts of basic science and the scientific method. This transformed the role of basic science, from primarily an academic pursuit of knowledge for its own sake as characterized by the science of western man, to a basic and directed tool of a government whose doctrine and objective is to foster the impending downfall of capitalism and establish the dictatorship of the proletariat, by Khrushchev's competition if possible, or by military if necessary. This paper will attempt to outline the singular importance attached by Soviet science and technology to the study of the physical environment and the implications of continued increasing knowledge concerning the physical environment of the entire earth as a factor in the future development of the power struggle. The paper of necessity is limited to a conceptual and qualitative description of the graving threat since methodology is lacking

to develop the necessary quantitative measurements of the rate of progress in the accumulation of physical environmental observational data or a comparative index in the ability to forecast and predict the occurrence of physical phenomena. The paper first outlines the ideological roots that have influenced the nature and direction of communist physical environmental research, and then summarizes historical evolution into the modern objectives and activities. The Soviet development of physical environmental research for domestic requirements is provided by a summary of programs and activities in geodesy, topographic and geologic mapping, and in Arctic research. Soviet expansion into world-wide research through international organizations as well as foreign aid programs is then analyzed, and some indication given of its value to the Soviets. The very advantages that accrue to the Soviets, however, when combined with Soviet policy of withholding information creates a serious disparity of decided disadvantage to the Free World. The nature of these disadvantages are then summarized and weighed with respect to the long-range power position.

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I. The ideological foundation of Soviet physical environmental research

American scientists who are becoming increasingly acquainted with Soviet geologic, geodetic and geophysical research are amazed and perplexed at the magnitude of the Soviet effort, the comprehensiveness of the research, and the almost sudden outburst of Soviet research on the international science scene, not to mention the wonderment at the vast support of Soviet science by the government.

A. Pre-Russian origins.

The great depth of the Soviet government's interest in science as a whole is fundamentally rooted in dialectical materialism as developed initially by Friedrich Engels. "Dialectical laws are really the laws of the development of nature---", they are "abstracted from the history of nature and human society---", and not merely laws of thought to be foisted upon nature as idealist Hegel asserted. Engels further asserts that laws of thought and laws of nature are necessarily in agreement with each other if only they are correctly known. Thus, ever-increasing knowledge of nature is essential. Moreover, the study must be comprehensive since the whole of nature forms a system, an interconnected totality of bodies -- all material existence from stars to atoms. "since they are interconnected they react on one another, and it is precisely this mutual reaction that constitutes motion". The end goal of man's increasing knowledge of the laws of nature begins with the consciousness of conditions for useful actions. Later this grows into developing the means

of reacting on nature. Eventually as the humans "make their own history consciously, the less becomes the influence of unforeseen effects and uncontrolled forces on this history, and the more accurately does the historical approach correspond to the aim laid down in advance". This increased mastery over the uncontrolled forces in nature must be followed by organizing production and distribution "in a planned way". The particular role of the earth sciences is also explained by Engel. In the study of the history of life, "after the transition from chemistry to life has been made, then in the first place it is necessary to analyze the conditions in which life has been produced and continues to exist, i.e. first of all geology, meteorology, and so on." While the concepts of Engels did not represent a new basic contribution to human thought -- he merely combined the ideas of the evolving scientific method and combined it with an anti-idealist twist of Hegel's dialectics (thesis, antithesis and synthesis) -- his ideas did contain significant attributes which when adopted and implemented by a large state led to the industrial development and military power of the USSR on the one hand, and its marshalling present military power in support of an aggressive system of revolution on the other. These attributes were: (1) the basic importance for the study of all of nature -- macroscopic and microscopic -- based on the concepts of the scientific method, (2) the unity of nature and the importance of interconnected

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unifying approach through studies of all disciplines, (3) establishment of man's mastery over natural phenomena, and (4) the need for social production based on a planned economy.

B. Leninist roots.

If Lenin was not an innovator of new ideas in the development of the dialectical materialism of Friedrich Engels he was a most dynamic implementer of those concepts in the organization of the new state. He outlined the great interest of the state "in a systematic development of science and technology, the growth of scientific cadres, and to continuously strive to make the achievements of science the property of the broad masses of workers ---".

Despite his preoccupation with military political and nationality problems in the organization of the revolutionary government, Lenin must be credited for (1) an early introduction of representatives of the world science into the top policy-making levels of the new state and (2) introduced physical environmental research into the core of the Soviet plans for industrialization. Lenin's primary concern, when not directing military operations or struggling with the famine, was to develop the economy of the new republic -- both as an immediate necessity to defend itself against formidable imperialist pressure, but as a basic prerequisite to the attainment of communism -- since Marxist conceived communism to be attainable only with the proletariat of an industrial society. For Lenin the core task was the raising of the productivity

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of labor, and the first necessity was to develop a heavy industry for which a resource base was required. He directed the Academy of Sciences to undertake a systematic study and exploration of natural resources, and in the name of the Supreme Soviet of National Economy to develop an order that would set up a series of commissions of specialist to draw a plan to re-organize industry and raise the economic level of the country. The plan was to provide for massive electrification of industry and agriculture, with the distribution of industry and power stations developed on the principle of proximity to natural resources, and also to make industry self-sufficient in raw materials. The Council of Peoples Commissars in 1918 "acknowledged the necessity to finance corresponding work of the Academy and to show its important and immediate task for a systematic solution of problems of the correct distribution of industry in the country and the most rational use of economic resources." The program of the Academy was reviewed and changes undertaken to reflect the new assignment. Out of the small sections of the Commission on Natural Resources began to develop large institutes within as well as outside of the Academy. These institutes were given direction in their work related to concrete tasks concerning the utilization of the natural wealth of the country. Even during the civil war the Academy organized a large expedition for the study of the famous Kursh Magnetic Anomaly - a large ore body, and in 1920 the Academy organized explorations of the Kola

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Peninsula. Out of the 1918 Academy assignment emerged another far-reaching act: the formulation of a decree by Lenin establishing a central mapping authority and establishing a national requirement for the mapping of the entire country. In less than 40 years the Soviets mapped their entire country at 1:100,000. Lenin even laid the foundations of Soviet polar research in 1923. During this period the Academy expanded its activities to encompass a number of fields -- mathematics, physics, chemistry, geology, astronomy, biologic studies, and even linguistics.

C. The Post-Lenin Expansion

In 1925 the Russian Academy was elevated above its own network of stations into the Academy of Sciences of the USSR, and the government called on a closer tie to the revolutionary masses and "to give them the results of victory of the human brain over the forces of nature." By 1929 the Academy membership was broadened and engineers became associated to mark the increasing direction of effort toward socialist construction. "The philosophy of dialectical materialism became victorious as the basis of scientific work." In 1933 the Academy was attached to the Council of Peoples Commissars to establish closer integration of the Academy with the commissariats (now, ministries) and collaboration with Gosplan. The decree of 1935 outlined the basic functions: to concentrate on the largest and leading problems of science; to study the natural resources and productive capacities of the country including the cultural and economic achievements of man

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facilitates their timely and rational utilization; facilitates the elevation of qualified scientific workers; and serves the government organs with scientific expertise. In 1936 the Communist Academy was joined to the Academy of Sciences broadening its coverage from the natural to include the social sciences. As the Academy expanded into a large association of specialized scientific research institutes it increased its role in serving the requirements of theoretical research as well as the applied research requirements of industry and agriculture. As the highest scientific establishment in the USSR it not only is responsible for research on the greatest scientific problems but also performs a coordinating role of the scientific-technical activities of the research establishments and of industry. One major function of the Academy is to organize all-union conferences, colloquiums, and meetings, on specific problems of science and technology for which scientists and engineers from all parts of the country are working in various establishments and departments. Such extensive coordination of effort reflects the application of the basic dialectic principle of the unity and interrelationship of phenomena which requires a multi-faceted approach to determination of the laws of nature.

## II. Outline of Communist Objectives and Activities in Physical Environmental Research

Lenin's early introduction of the Russian Academy of Sciences as an agency in the formulation of scientific plans for economic

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development was accompanied with the adoption of dialectical materialism of Engels and Marx as the credo and gospel which was to mold the orientation of communist research. Just as the Bolsheviks were called the scavengers of revolution so they also chose to name themselves as the sole heirs of the legacy of civilization's emergency scientific method. Facilitated by the upheaval of the revolution, the Bolsheviks succeeded in adapting a sound scientific approach in the earliest period of their organizational history to the planning of research for the practical requirements of the national economy and defense. A typical summary of communist doctrine conceiving is provided by Major General G. I. Pokrovskiy, Engineering Technical Services, Soviet Army, (1956), "the development of science is inseparably linked with practical life - i.e. with the development of productive forces". ---The developmental need of economic productive forces, and the class struggle, all these, are the motivating forces in the origin and development of science." Materialistic science "--is a system of knowledge encompassing the objective laws of nature and of society--". Using Marxist dialectical methods phenomena are analyzed, generalizations are formulated, and general laws are sought out to which these phenomena are subordinate. This provides scientific foresight which is "able to solve any practical task successfully." Thus, being able to foresee events, science becomes a "tool with which man can make practical changes in the world" -- a

\*On this premise the Lysenko controversy -- that man-induced changes in genes can become hereditary -- is not the pseudo-science and an inexplicable paradox difficult to reconcile with the high scientific standards in other fields. To the Soviet this is not too dissimilar from the goals of early nuclear research and experimentation.

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tool for the subjugation of the forces of nature and society to the interests of society." It was "scientific foresight" derived from successes in atomic physics whose "purely theoretical prognoses" of successful atomic explosions led to the creation of atomic bombs and atomic technology. This control of the microcosm was reiterated as a goal for the whole of Soviet science by the late Academician Igor Kurchatov, leading Soviet nuclear physicist at the time, in his address to the XXI Party Congress with the following closing words: "the scientists of our great motherland will, together with their party, with the entire Soviet people, labor unceasingly to make man the true master of nature in communist society." The same concept was also reiterated by Pokrovskiy commenting on the 1960 Soviet Pacific missile tests when he said: "the conquest of cosmic space is neither the sole objective nor the fruit of 'pure' science divorced from the requirements of life. It is the next logical stage in the conquest of nature by man." The application of these concepts to the world between the micro- and macrocosmic -- the microcosmic was also spelled out by Yevgeniy K. Fedarov, geophysicist and leading Party spokesman in the field of geophysics. He describes the objectives of studies concerning the Earth -- geology, geography, geophysics, geochemistry, geodesy, etc., -- the providing of society with the best possible means to utilize the favorable and useful characteristics of nature, and at the same time to search out means of defense against harmful and unfavorable elemental phenomena. These goals are to be achieved through research in the resolution of three

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tasks: (1) observation, description and analysis of natural phenomena, their genesis and interrelationship; (2) the forecasting of the development of phenomena in a time sequence; and (3) the study of the possibilities and means of exerting active influence on geophysical phenomena for the purpose of controlling their development to serve the needs of humanity. But the Soviets recognize (Pokrovskiy, 1956) that the status of knowledge, of generalization, of deducing general laws and the resultant capability to predict events in nature and control them is not at the same level. For the fields of atomic physics and the prediction of movement of bodies through outer space, "space rockets and long-range rockets"\* success has been outstanding. But he notes that "despite all successes of atmospheric dynamics, we are unable to predict precisely even one day in advance the simplest and the most basic characteristics of the atmosphere and of the weather. Our knowledge in a number of fields of geophysics, geology, and biology is even less perfected." Such a categorical statement of a basic deficiency cannot be underestimated as a statement of Soviet objectives in physical environmental and biological research. This conclusion seems to be re-affirmed by Pokrovskiy, when, speaking of the great importance of physics but the insufficiency of limiting knowledge to just general physics alone, he says "the whole environment in which military operations take place (including weather, visibility, passability of the terrain, defensive qualities of the terrain, camouflage, reconnaissance, the use of auxiliary equipment, and much more) can best be understood and utilized only when the physical

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\*This was written by Pokrovskiy in 1956 before the launching of the sputniks and missiles

bases of the corresponding processes are clear." In other words, the totality of physical environment and weapons systems can become most effective when by an understanding of the processes produces "scientific foresight" and a capability to "foresee events." It would further follow that given more or less equal forms and levels of weapons development, military superiority would accrue to that nation having superiority in the ability to forecast the behavior of physical environmental phenomena and control nature. That these objectives are important to military applications is made amply clear by Pokrovskiy: "At the root of the development of military technology lie mankind's achievements in the field of understanding the objective laws of nature and in the field of understanding the means of controlling the forces of nature". "Deep scientific foresight is exceptionally important in military affairs."

The task of developing the capability of forecasting and control is conditioned fundamentally by certain unique aspects of physical environmental data. First, unlike many other fields whose data are observed, analyzed and manipulated under laboratory conditions within finite controllable limits, earth science data, by and large, are observable only in vastness of the earth as a whole, where controllable conditions for experimentation are essentially impossible. Second, in the words of Lloyd W. Berkner "description of any natural element of our surroundings as it appears must be made at sufficient distribution of points over the surface to permit generalization with the required precision." This is to say that each point on the

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✓ earth surface, or in space has properties or characteristics that are unique unto itself. In the final analysis, there are no substitutes for the observational data themselves -- they must be observed at each given point. This aspect takes on singular importance to the power struggle when the coverage of observations is limited due to inaccessibility -- physical, as in the case of polar regions, or political, as in the case of the Sino-Soviet Bloc. The goal of all of the earth sciences, therefore, must be the coverage of the whole of the earth, its seas and the atmosphere. An essential objective, therefore, is an ever-increasing collection of data on a world-wide basis. The problem is even more complicated by the needs of the dynamic geophysical sciences which (1) require continuous observations over an interval of time long enough to obtain all representative variations, and (2) synoptic observations, to provide the simultaneity of observation of a dynamic phenomenon over wide portions of the earth. It is readily evident, therefore, that the collection of data on an ever-expanding world-wide basis becomes an essential explicit goal to fulfill communist dialectical materialistic conditions of providing the necessary data in order that (1) analysis may be undertaken, (2) generalizations derived, (3) discoveries of objective laws formulated, and (4) the development of an ability to forecast or predict the occurrence of physical or environmental phenomena be achieved, as implied by Pokrovskiy, to a sophisticated level, comparable to nuclear physics or orbit prediction in astronomy. Because of the vastness of the world-wide coverage problem, the

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development of programs becomes truly monumental in terms of time and space, and accomplishments difficult to measure. Yet the large size of the Soviet research apparatus and their expanding world-wide activities indicates an inexorable march toward their stated goals. At what point a superiority may be achieved it is impossible to state. This objective of comparative progress is not known to exist within existent missions of intelligence research. Present efforts are directed to a measure of communist capabilities resultant increase in data based on analyses of personnel, organizations and personnel. Thus, while this rate of progress relative to the ultimate Soviet objectives is not measurable quantitatively at the present time some indication of initial advancement becomes evident from a survey of communist physical environmental research, first to meet domestic requirements, and second, from the Soviet expansion into world-wide collection of data. For reasons of emphasis, it must be stated that even in the domestic phase, the communist goals are always formulated and expressed in terms of the analyses of phenomena by the dialectical method, to derive generalizations concerning them, and to discover the general laws to which they are subordinate in order that prediction or foresight concerning them may be achieved. In the summary that follows only some of the more significant fields of research are treated for which sufficient data are available to provide some quantitative measure of progress or descriptive illustration of Soviet development toward their goals. Significantly the field of geography is omitted because Soviet

emphasis on physical environmental research has diffused Soviet geographic research into one or more of the other earth sciences, or to regional physical landscape description. The value of this research while intuitively known to be significant is not yet susceptible of quantitative measurement and expression. Soviet economic and political geography has been stifled by the dictates of Marxist economics and the doctrine of the class struggle.

### III. Soviet Domestic Development in Physical Environmental Research

#### A. Geodesy, Mapping

1. USSR. The origin of Soviet development in the earth sciences had its roots in the requirements of bolshevik defense, reconstruction and in the long-range planning for industrialization. As early as 1918 the Council of Peoples Commissars (now the Council of Ministers) was given a report prepared by the Peoples Commissariat for Land Reclamation on a centralized geodetic organization. About the same time Lenin requested the Russian Academy of Sciences to prepare a report on the activity of the Geodetic Commission of the Academy organized and active in the period 1914-18. Since the work of the Commission proved ineffective, Lenin requested the Academy to prepare a decree on the organization and responsibilities of a new state organization to direct the work on the mapping of the new republic. Such a decree, incorporating changes made personally by Lenin, was signed 15 March 1919. The mapping was to be undertaken "for the purpose of raising and developing the productive capacities of the country, the economy of technical resources, of funding, and of

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time ---". Heavy investments were made in the program, even during the time of the famine. Initially, heavy reliance was placed on imported equipment and instruments as well as some foreign personnel. Under Lenin's drive for self-sufficiency for the entire economy, a gradual build-up of native instrument production and a heavy program of training of personnel was pursued. After a long period of organization and re-organization geodetic surveying and mapping became centralized through an inter-departmental body in a civilian agency, GUKK, the Army, and the Navy. While various programs in surveying and mapping are undertaken by a large number of ministerial or so-called production enterprises their activities are integrated into a uniform program and implemented through unified specifications. Noteworthy is the vertically-integrated development in the Soviet Army of all phases of surveying and mapping activity -- including field parties, all forms of map compilation and production, scientific research and education including the granting of doctorates to military officers. As a result of the heavy investments in education -- including 5-year courses in higher geodesy\*, the Soviets are estimated to have developed a roster upwards of 20,000 engineers and technicians engaged in geodesy, photogrammetry and cartography for topographic map production\*\*. In this production the Soviets have made not only a

\*In the period 1937-1955 at least 42 Doctorates of Technical Sciences in Geodesy were granted. Up to 1955 no such advanced degrees were being granted in the U.S.

\*\*The US National Scientific Register, as a result of its 1956-58 survey, lists 1,375 classed as Engineers: surveying, mapping and photogrammetry.

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remarkable adaptation of the experience, methods and instrumentation of the Free World to a mass program but have developed instruments and techniques of their own, including super wide-angle lenses to provide the widest horizon-to-horizon coverage for use in their aerial mapping. As a result, in the space of 4 decades the Soviets completed the coverage of their entire country -- 2 and 1/2 times the size of the US -- at 1:100,000, involving more than 20,000 individual sheets -- an achievement that is still considered incredible by many Free-World map specialists. In comparison the US in twice the span of time has succeeded in completing less than one-half of its area.<sup>1/</sup> While much of the Soviet coverage -- chiefly in Siberia -- does not meet the high standards of the coverage of the more developed areas, the Soviets are now embarked on a program that will extend triangulation into the Siberian and Arctic areas<sup>2/</sup> by the end of the Seven-Year Plan, and topographic mapping is now concentrating on coverage of the entire developed areas of the USSR at 1:25,000, and the more important areas at 1:10,000. Despite the

<sup>1/</sup> The Soviet publication, Geodesy and Cartography, No.2, 1959 states that in many aspects Soviet geodesists and cartographers have already surpassed the geodesists and cartographers of the US. Notwithstanding the fact the US is much smaller in area, and environmental conditions are much more favorable, American geodesists and cartographers have covered no more than 40 per cent of their country. The completion of mapping at 1:25,000 and 1:62,500 is aimed for 1973. Soviet geodesists have already covered their country at 1:100,000, and will not fall behind in their large-scale mapping.

<sup>2/</sup> The bulk of the effort will be concentrated in regions of Eastern Siberia, the Urals, Far East, and Central Asia. By the end of the Seven Year Plan, i.e. 1965, 80 % of the topographic-geodetic work will be concentrated in the eastern and northern regions

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fact that some of the European satellites have had a good topographic mapping foundation, the Soviets in 1952 imposed an extension of their own geodetic and topographic mapping system into the European area by forcing a revision of all the national systems. The program is in the final stages of completion.

The Soviets have taken leadership in the development of geodetic gravimetry, which dates back to 1932 when the Soviet Council of Labor and Defense decreed the undertaking of a general gravimetric survey of the entire USSR which would establish a minimum of one observation per 1,000 sq. kms. (22,000 points). It has been of value both as a reconnaissance framework for resource exploration programs, and for the development of unique and original research aimed to simplify the long meridional extent of Soviet mapping.

Out of this research, however, the Soviets devised techniques which, if they continue to gain free access to world-wide gravity data of their own and other countries, will give them the means to easily establish geodetic positions in any unsurveyed area in the world without need to resort to triangulation.

2. Communist China. Mapping in Communist China has been undertaken under circumstances that disclose (1) the difference in Soviet relationship between the European Bloc on the one hand and the CHICOMS on the other, and (2) the universality of communist ideology and methodology. Similar to the Soviets, the Chinese

\*The US has no comparable survey. ? what

almost immediately launched a systematic mapping program but with indications that this was not imposed by the Soviets as with the European Bloc. The Chinese appear to have developed their own program, but with an unknown amount of acknowledged Soviet assistance. Progress appears to have been remarkable. Unlike the European Bloc countries, China established its own system of coordinates, Peiping 1954, with vertical control based on the Yellow Sea vertical datum. By the end of 1957 it is claimed that "approximately half of the territory of the country was well provided with modern high precision -- first-order triangulation and high-precision levelling. --- A considerable part of the country had been covered, by the end of the first five-year plan (1953-57), with new state topographic surveys on a scale of 1:50,000, and 1:100,000." The Chinese plan calls for completion of first-order triangulation in 1961, and for completion of the topographic map of all of China by 1967. These are to consist of coverage at three scale series: 1:25,000 for the more important areas, 1:50,000 for the remainder of the densely populated and economically developed areas; and 1:100,000 of the desert, mountain and high plateau areas. Again similar to the Soviet experience, this map series is being pushed to completion at the expense of omitting some details, for the plan proposes that after the first coverage is completed (1967), the maps will be revised by incorporating greater detail. Personnel employed in this work has increased to over 20,000.

**B. Geology**

1. USSR. The great importance attached to raw material production for the development of heavy industry and for Lenin's policy of autarchy laid the foundation for geological exploration and mapping that was to develop to an unprecedented level. By 1918 Tsarist geologists succeeded in covering only 30 per cent of Imperial Russia covered by geological surveys, of which 2.4 per cent was at scales or 1:200,000 or larger. From a depleted roster of 50 geologists in the Geological Committee, and a total of 150 in all of revolution-torn Russia, the number increased by 1936 to 1,690 geologists in the geological survey and 30,000 workers and service personnel, and by 1956 to 54,000 engineer-technicians\* of which 28,000 had advanced degrees, and 350,000 workers and service personnel. Drilling rigs increased from 100-150 at the time of the revolution with only 50-60 per cent in operation to 1,500, with 1,000 in operation in 1931, to 10,400 with 13,000 in operation in 1956. Geologic mapping in 20 years under the Soviets increased coverage to 50 per cent of which 6.8 per cent were at 1:200,000 and 2.8 per cent at 1:100,000. By 1956 98 per cent of the USSR is covered at 1:1,000,000, and more than 65 per cent at the larger scales (of which 40 per cent is at 1:200,000 or larger). Nearest comparable US figures on geological map coverage over 80 years of continuous activity amount to about 15 per cent at 1:62,500 or larger, (excluding Alaska and Hawaii) and about 50

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\*The nearest US figure available for comparison according to the national Scientific Register is 9,514.

per cent at 1:125,000 to 1:250,000. The benefits of such huge investments have brought significant benefits which is best epitomized in the high degree of self-sufficiency achieved in raw materials and in the tremendous and rapid industrialization. One brief quantitative illustration of Soviet benefits from its geological achievement programs is provided by recent Soviet revisions in the estimation of world coal reserves. The asserted Soviet proportion has increased from 21 per cent of the world totals to about 50 per cent. Current Soviet geological research is being continued for an intensified search for raw materials under the pressure of diminishing reserves of economic deposits, and expanding requirements of increasingly complex industry. Soviet science is admonished to concentrate on the problem of developing the laws of the distribution of mineral resources. "The problem is complicated by the necessity of forecasting [deposits] in the most accessible areas -- which -- must be of high enough quality and occurring in conditions suitable for progressive methods of exploitation." "the study of the theoretical foundations of natural laws occurs in conjunction with the compilation of maps showing known and prospective distributions -- of minerals". One program contemplated calls for the compilation of metallogenic maps in three scale categories: general metallogenic of the USSR (1:1,000,000 and smaller); medium-scale prognostic-metallogenic maps of large ore provinces (1:1,000,000 to 1:200,000); and large-scale prognosis maps of individual ore regions (1:200,000 and larger). Some idea

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of the magnitude of this effort is provided by the fact that in 1959 alone 620 topics were in work by various geological research organizations. The compilation of small- to medium-scale (1:1,000,000 through 1:200,000) prognosis maps of mineral distribution is one of the specific tasks of the Seven-Year Plan. Work on this problem is said to be lightened by the geological mapping that has been done or is underway. Another significant trend in Soviet geological research planned to reflect the party directives for the Seven-Year Plan is the intention to transform geology into "an exact science using the methods of geophysical science to solve problems pertaining to the structure of the upper layers of the earth's surface." By 1965 25 per cent of the geological surveying will be done by geophysical methods: gravimetric, aeromagnetic, seismic, radiometric, electro-exploratory.

2. Communist China. Geologic exploration, similarly to geodetic surveying, has also been given considerable emphasis in the CHICOM programs for the development of the country. The magnitude of the effort is shown by the increase in the number of geologists the last few years, from several hundred to 400,000. There are now three large geologic institutes, 25 technicians, 22 universities with faculties of geology with a total enrollment of 36,700. There are now 21,000 geologists in communist China. Geological exploration is conducted not only by provincial geological administrations (a number of which have their own scientific research institutes), but also by 10 scientific research institutes in the Chinese Academy of

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Sciences, and by a number of units of production ministries. The ambitious topographic mapping discussed previously is being utilized as a base for geological mapping thus greatly facilitating the progress of surveying and providing a sound scientific foundation. This appears reflected in the claimed high rate of geological mapping progress. By 1958 22 per cent was covered at 1:200,000; nearly 7 per cent at scales larger than 1:200,000, and at the end of 1957 13 percent at 1:1,000,000 to 1:500,000.

C. Arctic Research. The development of Soviet Arctic research has played a significant role in the expansion of Soviet physical environmental research from goals designed to meet domestic economic requirements to objectives requiring research on a global scale. Early Soviet Arctic research, dating back to 1921 when Lenin's decree founded the Floating Marine Scientific Institute, was undertaken primarily as a limited effort aimed eventually toward a gradual development of the Soviet economy. But the formulation of plans in 1932 to open up the Northern Sea Route took on the character of a major effort in the development of the Arctic regions. Soviet initial expansion of shipping proved overambitious when a series of mishaps arising from inadequate information on the harsh physical environment culminated in a number of disasters in 1937. The Soviets became confronted with the basic need for reliable forecasting of weather, ice conditions, currents, etc. Realizing again the interrelationships of various phenomena, the Soviets launched into a variety of basic research programs designed to substantially

brodden the coverage and increase the volume of environmental data. A variety of unique methods were developed to collect the necessary information; research facilities were expanded or new ones established to undertake studies that would improve the forecasting required for reliable shipping operations, and extend the shipping season eventually to six months. Data collection was expanded from coastal Arctic stations deep into the interior of the Arctic Basin. The successful operation of drifting stations was proven by NP-1 in 1937. Aircraft were developed as "flying laboratories," instrumented to make simultaneous weather and ice observations from the coast deep into the interior of the Basin. Instruments were placed on ice-breakers for weather and ice observations, some being detailed explicitly for additional studies of the pack ice. Scientific teams were combined with the operations of flying laboratories, and landed at numerous, otherwise inaccessible areas where observations were made from ocean bottom to the significant elevations in the lower atmosphere. By 1954 the Soviets developed the first of what now has become a series of High Latitude expeditions which combine flying laboratories, mobile research teams, and drift stations to collect the widest range of synoptic observations. While the Soviets do not provide any comprehensive summaries of observations obtained from their complex program, some indications of magnitude can be gleaned from the brief summary of the variety and number of observations obtained by SP-3 and SP-4 drift stations

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over a 7-month period

- (1) 3,000 radiosondes and balloon launchings
- (2) 20 deep-water hydrological stations established
- (3) 1,000 ocean soundings
- (4) 18,000 observations of ocean currents
- (5) 700 determinations of magnetic declinations
- (6) 1,700 magnetic observations
- (7) 500 solar radiation (actinometric) observations
- (8) 1,300 aerometric observations
- (9) 10,000 meteorological observations
- (10) 700 astronomical fixes.

Up to the present time 12 air expeditions have been launched, and the ninth drift station is in process of being set up. As a result of this tremendous effort the Soviets boast, and rightfully so, that they have more information on the Arctic Basin than any other nation in the world. The Soviets for example, are known to have made landings at several hundred points in the Arctic Basin up to the North American coast itself (Figure 1). They are now devising a television system of ice observation that transmits ice conditions to central points for correlation with other weather information in the preparation of synoptic ice and weather charts.

D. Soviet Competence in the Earth Sciences. It would not be enough to merely have a voluminous effort in data collection, if the competence of the work were less than adequate. The most recent NIE 11-6-59: Soviet Science and Technology in general rates the Soviets very well in various earth science fields.

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1. Polar geophysics. The Soviets are world leaders in this field. Their advancement into Antarctic research is comprehensive, primarily to advance their coordinated studies of the earth as a whole.

OS/ 2. Meteorology. Work in weather and meteorology is competent. Research in weather modification and basic cloud physics has paralleled work done in the West, and the Soviets will strive to develop additional weather control techniques. Extensive control of weather, however, is not expected. Significant advances are expected in Soviet upper-atmosphere and solar-terrestrial relationships.

OS/ 3. Oceanography. Soviet research has been more extensive than that of other leading nations. The Soviet work is of high quality in polar areas, and in marine biology and marine geology. Over the next decade Soviet forecasting of the thermal structure of the ocean will produce applicable results for increased competence in ice forecasting, for predicting sound range conditions, and for meteorological applications. As yet the Soviets are behind the US in chemical and dynamic oceanography, and instrumentation, although improvements in these can be expected.

OS/ 4. Seismology. Soviet research is intensive and well supported with adequate facilities. The seismic network has increased from 20 to over 100 since 1945, and the equipment is excellent. Due to the scope and intensity of Soviet research it is likely that Soviet capabilities in many areas of seismology will exceed those of the US in a few years.

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5. Geomagnetism and Geoelectricity. The Soviets have an extensive research program, including the only non-magnetic research cruises of the Zarya. Soviet earth current research, which surpasses that of any other nation, may already led to significant military applications.

6. Geodesy. Soviet geodesists, among the world's foremost, have been well supported in domestic surveys and in theoretical research giving them a head start toward achieving a world geodetic system essential for missile operations.

7. Geology. The Soviets over the next decade are likely to expand their high capabilities in the subfields of geology. The USSR is now outstanding in geochemical prospecting and permafrost science and will probably remain so for the next 10 years.

#### IV. Soviet Emergence and Expansion into Physical Environmental Research

##### A. Roots of Soviet Interest

No single period or research event can be defined that would identify Soviet interest to expand into a world-wide program of environmental research even though such interest is known to have existed for a long time. In fact the roots of Soviet interest in the study of the earth as a whole can be said to derive from the concept of dialectical materialism which asserts that the study of the whole of nature is the study essentially of all matter, its motion (or change of states) and the interrelationships between the various forms of matter and its motions. It is not surprising therefore that the Soviets despite a traditional policy of isolation from

international scientific activity found it advantageous to cooperate in the International Meteorological Organization (IMO). In still another field, geodesy and geology, early interest of necessity led to an eventual interest in the study of the earth both as a geodetic and as an astronomic body. Such interest probably began to emerge in the late 1920's, for by 1937 Krasovskiy already laid out a concrete plan to develop a special triangulation arc explicitly to effect an intercontinental tie with North American triangulation via the Bering Strait.\* It is not surprising, therefore, that by 1953 this world wide interest was given expression by Professor Zakatov, one of the leading geodesists, when he wrote that Soviet scientists have raised terrestrial research to a new level as the "conjoined research in higher geodesy, geophysics, and geology -- directed to a deeper study and utilization of the indeterminate wealth of our great Motherland." Probably parallel with this interest in geodesy, other interests began to evolve in other earth sciences fields in the course of the 30-year development of research on domestic problems,

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\*In contrast to the membership on the IMO, the Soviets rigidly abstained from any international contacts where geodesy or mapping was concerned. For example, the Soviets ignored the Tsarist adherence to the convention on the millionth map of the World project, and did not participate in the meetings of the International Union of Geodesy and Geophysics until 1957, probably because they had more to lose from the aspect of national defense in giving up maps or geodetic data than they could gain from participating in the work of the IUGG or the IUGG at this time. It is noteworthy that even though the Soviets are now members of the IUGG they still refuse to divulge any information on triangulation, location of large-scale mapping or any similar geodetic data.

e.g. geology, mineral exploration, ground water surveys, seismology, and polar research. Under the dictates of dialectical materialism on the one hand, and the self-generating nature of earth science research on the other, the Soviets were destined to develop a broad interest in world-wide studies. So evidence began to appear that the Soviets were interested in developing a geological map of the world, in the study of the world ocean, in the collection of gravity data on the whole of the earth, in seismology, geomagnetism, and, of course in the world-wide interrelationships of weather and atmospheric processes. By the 1950's it was only a matter of timing and favorable circumstances when the Soviets would break with their isolation, and risk participation in international organizations and programs. It may well be that the Soviet completion of the complex oceanographic survey (including the use of surface ship pendulum observations) in the Bering Strait and the adjoining North Pacific in the period 1950-53,\* and the emergence of the first of the complex Arctic High Latitude Air Expeditions in 1954 represented the attainment of that degree of sophistication and readiness to warrant an expansion into the IUE and subsequent world-wide research.

B. Entry into International Programs.

It is significant to stress that Soviet policy had traditionally isolated Soviet earth scientists from foreign contacts, although also as a matter of policy, laid down by Lenin himself, every effort was to be made to capitalize on the best and most advanced of bourgeois

\*Figures 2, 3, and 4 show the progression of expanding Soviet oceanographic research.

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science developments. Hence for most of nearly three decades the Soviets tried to maintain a one-way flow of information. One significant exception to this policy was in early Soviet membership in the International Meteorological Organization and its subsequently sponsored project, the International Polar Year, 1932-33 in which the Soviets participated.

**B. Entry into International Programs**

Whether the Stalin regime was the cause of such isolation or not has not yet been established. In any event, the Soviets made their biggest break with past policy by their decision to participate in the International Geophysical Year Program, and shortly afterward to become members of the International Union of Geodesy and Geophysics. When their program unfolded it developed into one of the most comprehensive and ambitious of all participants. In the field of oceanography its effort, judged by the number of ships, was the largest of all. With the successes of their artificial satellite program the Soviets have made great strides in achieving recognition as equal to the US in many of the fields and superior in some (oceanography, satellite).

Unlike their policy following the IFY when they retreated into the isolation, the Soviet policy reversed itself after the IFY and manifested considerable initiative to secure continued IGY cooperation into the IGC -- International Geophysical Cooperation, which is now being conducted through various special committees of the International Council of Scientific Unions (ICSU). These

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now include Special Committees on Antarctic Research, on Outer Space, and on Oceanography. The Soviets are also members of other international organizations such as the International Geological Congress, the International Astronomical Union, the International Astronautical Federation, and others. In addition, the Soviets have also embarked on a program of exchanges of scientists. The major theme is: coordinate programs, and exchange information.

The decision to enter into international scientific programs and organizations after a long history of isolation appears to have been motivated by: (1) a fundamental realization that the IGY and related programs would provide world-wide data indispensable to Soviet long-range objectives and not previously or otherwise available; (2) an assessment that on balance Soviet research objectives and programs would benefit more from participation than other nations because of the more elaborate Soviet scientific research organization; (3) an assessment that Soviet science had come of age and could not only hold its own, but was ready to do battle in the cause of demonstrating the superiority of the communist system and communist science; (4) an assessment that the only risk - the release of data of military importance could be protested by skillful evasion and passable subterfuge.

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\*In fact, in the announcement of Soviet participation in Rome, 1954, the Soviets made a plea for an expansion of work in gravity, even though the subject is not one of the dynamic fields and even though it later developed that the Soviets had made no attempt to do this in their own program within their own country.

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It is significant to the thesis of this paper that the Soviet program for the IGY by no means limited itself, and as the US program did, to the IGY program. The Soviets from the very beginning undertook programs, particularly in Antarctica, in geology, geography, mapping, resource exploration, air and sea navigation studies, and preparation of pilots. In other words, the Soviet interest was in more than the IGY, and for a much longer duration than the 18-month period of the IGY. It would appear that Soviet world-wide research is here to stay.

C. Appraisal of Benefits of IGY Participation

1. US Appraisal. NIE 11-6-79 states: "The USSR was one of the largest contributors to the International Geophysical Year, and is still engaged in a world-wide program in nearly all of the IGY scientific disciplines. To date, the Soviets probably have acquired a tremendous amount of data of strategic value, and have released a considerable volume -- designed to enhance Soviet scientific progress. However, in view of the nature of the material released so far, the Soviets will probably release little specific data which might be of direct military value to the West.

2. Soviet Appraisal. The Soviets have widely hailed the great value of the IGY and strongly plead for its continuation indefinitely. Dr. V. V. Belousov, Soviet representative on IGY matters, provides a useful summary of the values of the IGY to the Soviets. The enormous volume of observations, their coordination has made the IGY an unparalleled example of fruitful cooperation. Discovery was

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made by the Soviets of the outer radiation belt, while American and Soviet scientists discovered the inner belt. The IGY made possible the first compilation of daily meteorological synoptic charts compiled for the whole of the earth. Research has shown that the Antarctic's climatic influence extends far to the North, and in some measure to the whole world. Among a number of Soviet discoveries -- deep trenches in the Pacific, an underwater range in the Arctic Basin -- the Soviet discovery that deep water currents travel 10 to 20 times faster than believed has served to prevent dangerous radioactive pollution of ocean waters which might have resulted from American and West European proposals of scientists to dump radioactive wastes into the ocean depths. Glaciological observations of the IGY and the resultant inventory of all perennial ice on earth has shown that there is much more ice than believed earlier, and that the ice is receding. Especially valuable are the countless IGY records of the most diverse geophysical processes throughout the planet. Never before has so much material been obtained by simultaneous observations. Its processing will yield many new scientific discoveries. Academician Bardin indicates that in the USSR 18 government bureaus and 90 scientific establishments and advanced schools participated. Bardin also adds to the list of benefits from the IGY. Results of direct exploration by rockets and satellites not only brought useful results in geophysics but also permitting the formulation of broad generalizations on the structure composition and evolution of the Earth. Ionospheric research will

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aid in the solution of many problems, for forecasting and radio communications. Concepts of ocean floor topography have been altered, and colossal mineral resources uncovered. Integrated processing of oceanographic and meteorological data and the dynamic interaction between atmosphere and ocean will have great significance in the improvement of short-term and long-term weather forecasts.

Glaciological discoveries may support the fantastic idea of destroying the permanent pack ice of the Arctic for purposes of improving the climate of vast areas of the Soviet Arctic and northern Canada, an idea that is arousing much interest in the US and Canada. It is little wonder, then, that Barin makes the strongest plea that the program of observations for the IGY be continued and the same level of observations at the stations and observatories that was attained in IGC-1959, the successor to the IGY, and beyond.

**D. Soviet Foreign Programs as Additional Means of World-Wide Data Collection.**

The list of Soviet projects (Figure 5) in the various aid programs includes those which by their nature would be adaptable to the collection of physical environmental data. Whether these projects were intended to be so used is immaterial. Some of the programs are comprehensive geophysical or geological surveys. Other smaller programs are also important for each provides an opportunity to collect unique exploration or mapping data. Another significant though less suspecting activity is the training of indigenous personnel (Iraq) or the construction of educational establishments (Guinea) or research

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institutes (Indonesia). These afford opportunities to secure among others, two objectives pertinent to future scientific relationships: (1) scientific training in the dogma of dialectical materialism, and (2) training in Soviet methods and techniques. The former secures another convert to a cult of Soviet science with the erroneous impression that only Soviet science performs on the principles of the scientific method. Such a convert becomes another disciple to the cause and a willing contributor of data to the USSR. With training in Soviet methods and techniques the Soviets secure prospects for more homogeneity in the data collected.

There are indications that earth scientists may become the "bird dogs" of future aid proposals. This is suggested by the formulation in the USSR in 1959 of a Soviet Association of Friendship and Cultural Cooperation with Latin America. Two of the four vice-presidents selected are outstanding Soviet physical geographers. Designed to interpret Soviet life to Latin America the unusual appointment of geographers suggests their use to establish contacts with geographers, strengthen the flow of geographic data to the USSR, and possibly assist in the formulation of aid programs.

The almost universal inclusion of terrestrial surveys and mapping suggests a Soviet determination to utilize such an inherently systematic approach to the raising of the productive capacities that proved so effective in the USSR. Moreover, such support is invariably given to socially-owned enterprises which to the Soviets promises to lead to eventual communism.

V. Current and Future Disparities in Knowledge of the Physical Environment

A. Disparities Due to Sino-Soviet Withholding of Information

The comparative status of knowledge concerning the physical environment takes on a unique significance because at any given point or area there is a unique combination of elements and dynamic characteristics which can become known only from studies of observational data. Without these data or with unequal access to these data, knowledge becomes unbalanced, and the disparity can have an ultimate adverse effect on the power relationship. The Sino-Soviet Bloc enjoys certain advantages by virtue of a long-standing policy of withholding a variety of basic environmental information concerning the vast area of the USSR, comprising one-sixth of the earth's surface, plus Communist China with an area larger than that of the US. This a direct consequence of a deliberate policy intended to make secure the national defense of the Soviet Union.

The principal materials withheld include all postwar sheets of the topographic map coverage (1:500,000, 1:300,000, 1:200,000, 1:100,000, 1:50,000, 1:25,000, 1:10,000, and larger) and most of the sheets of even the 1:1,000,000 series; all postwar geodetic catalogs of the latest unified geodetic system, all gravity catalogs, all detailed catalogs of geomagnetism; all geologic map series at scales larger than 1:1,000,000, and all but about one-third of the 1:1,000,000 series. Despite its membership in the International Association of Geodesy, IUGG, the Soviets are

withholding all maps and catalogs, and even withholding information on triangulation and levelling networks. When confronted directly with the request for gravity information, the Soviets resort to the lie in order to evade dissemination. On the basis of information from one aid-recipient country, it is believed that the Soviets attempt to establish comparable security protection over survey data of aid-recipient countries.

While this is being withheld, the Soviet Union, with its vast and elaborate system of collection and processing of foreign information, has probably collected most if not all of the available information on the rest of the world.

Although the IGY was established on the principle of free exchange of information, the fulfillment of this performance is not subject to review. While the Soviets acquired a tremendous amount that is of strategic value much of what they have released has been of prestige value, or of a nature that has no direct military application. None of the materials mentioned above have become available either because the materials predated the IGY or, as in the case of the topographic and geologic maps, and the geodetic and gravity catalogs, they were not substantive parts of the IGY programs. This was explicitly confirmed in 1956 when the Soviet scientists, in a generous gesture of cooperation, disseminated declassified reports on the Arctic. Nevertheless, the sections concerned with gravity and geomagnetic data were cut out. Many of the data released are known to be

given in generalized or processed form and not as raw data. The Soviets were also known to be withholding some of the communications codes of their own satellites, making it impossible to decode the transmitted information. So long as this condition is allowed to continue, the Western World, with its traditional policy of freely exchanging information, will find that the gap of disparity is ever widening and that the Soviets are accruing an increasing advantage in ultimately developing superior knowledge of the physical environment. The assessment of the magnitude and measurable consequences of this disparity has not as yet become a specific subject of study.

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B. Disparities Arising from Soviet Purposefulness Method and

Organization

The influence of Engel's concepts, which incorporated the sound elements of the scientific method, led Lenin to accord a basic recognition of the value of scientific guidance by incorporating it in the earliest planning of communist development policies. Out of this emerged a consistent, steady fiscal support of science that fostered the long-range development of scientific facilities, programs and the training of personnel. Constant demands of national growth on science supported by evidence of productivity, evidently generated an expansion of national-supported scientific research and development that was unprecedented in annals of nation state development. Contrary to widespread misconceptions that such utilitarian motivations would displace and stifle basic research, the comprehensiveness of dialectical materialism which defines itself as "the manifold study of the development, the universal relationship and mutual interdependence of phenomena" provided the essential justification and support for basic research. This is evidenced by the contributions of Lobachevskiy, Krasovskiy, Kapitsa, Ambartsuniyan, and a host of other basic scientists. The application of systematic principles in the formulation of policies for the discovery and development of natural resources, the improvement of land use, the development of virgin areas in regions of forbidding physical environmental conditions was reflected in the early implementation of comprehensive surveying and mapping programs -- topographic, geologic, hydro-geologic, geographic, soils,

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vegetation, etc. Out of these motivations and policies has emerged a vast, effective scientific structure which has become the envy of more than one scientist -- US and others. It is capable today of undertaking its own increasing data collection programs, adding to it the data collection of other countries and subsequently undertaking the essential processing of data in association with research studies. The implications of the vastness of this structure and the purposefulness of its operation has worried US scientists -- some to a point of disillusionment -- in government and in academic circles because it is unmatched anywhere in the Free World. Directed to the broad objective of evolving increasing mastery over natural forces, the comprehensiveness of communist ideology has also led to the distinctive development and widespread use of the "collective research" method. This method combines a variety of disciplines to bear on a single research problem. Unlike the US where the team method has been developed almost entirely -- and very effectively -- for industrial research, the Soviets apply the method to basic research. As a consequence the combination of directed purposefulness, concentration of attack and large size that gives the Soviets a long-range time advantage in the achievement of their objective -- forecasting or prognosticating the occurrence of natural phenomena, and developing mastery over the forces of nature. Free World science, on the other hand, for its program formulation depends essentially on the casual motivations of individual scientists engaged in the search for truth, usually within the individual confines of separate disciplines.

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Whatever the philosophical merits of each approach, the fact is that when science is being used as a tool of an anti-liberal state policy, the communist method is likely to get its objectives "fustest with the mostest."

#### VI. Long-Range Prospects

The Sino-Soviet Bloc can be expected to continue its policies of expanding its world wide collection of data on its own and by encouraging international scientific programs to provide additional data for Soviet scientific objectives. At the same time it will continue its anti-liberal policy of withholding as much information as possible, releasing only those data not having sufficient direct military value, as a kind of pay-off to keep international programs from drying up. This policy stems from communist objectives to (1) secure the establishment of communism by war or peace, (2) develop increasing mastery over nature for application to peaceful development or to provide superiority in prediction and forecasting for Soviet military operations. Soviet physical environmental research, which has demonstrated its effectiveness and gained recognition in its basic contributions to (1) Soviet industrialization and other national economic development, and (2) the support of military operations during the past wars. In the course of these activities communist science has reached a high level of capability and sophistication which now can be used for the broadened phase of world-wide research, and which is essential if communism is to achieve its long-range objectives. Moving out into world-wide research communist serves

to fulfill its scientific requirements and at the same time to provide benefits toward the intermediate goals of advancing communism. This is accomplished in two ways: (1) participation in international scientific research, which not only increases the collection of data but also affords an opportunity to show off communist science; and (2) support of Soviet foreign aid programs in underdeveloped areas, which not only provides still another opportunity for data collection but also provides effectiveness to aid programs through basic, systematic resource survey and mapping projects, as proven in the development of underdeveloped bolshevik Russia. International participation further serves communist purposes in the struggle for men's minds by the subterfuge of identifying the effective use of the scientific method exclusively with dialectic materialism as the only ultimate means for intellectual, human development, while at the same time portraying bourgeois science as ineffective, sterile and employed exclusively in the interest of profiteers and warmongers.

Soviet policy of withholding basic physical environmental data on the one hand, while it reaches out for the freely-given information on the other, places the Communist Bloc in a superior position, since physical environmental data are by their nature unique and distinctive. The inability of the Free World to overcome this disparity in data except by extra-expensive and time-consuming techniques creates a serious time lag which is not likely to be sufficiently overcome for years to come. As a consequence purposeful, dynamic, highly-integrated Soviet physical environmental research could give significant superiority

What is  
the lag?  
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the actual  
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for an extended period of time. The great danger is that such an advantage is difficult to identify to sufficient people, and the danger is presently not susceptible of measurement. This may well underscore the real portent of Khrushchev's "we will bury you": superiority in peaceful competition, or alternatively, superiority in military operations.

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